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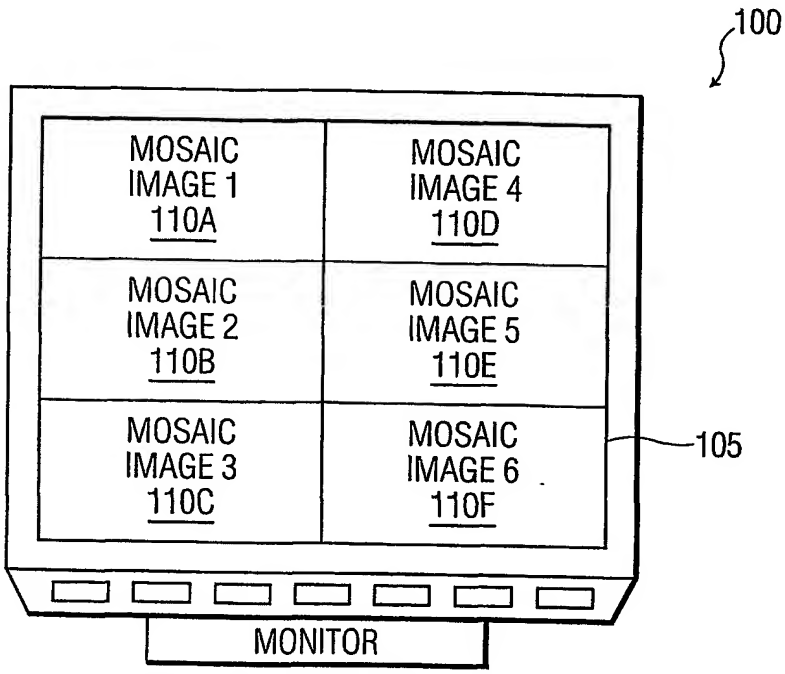
[Continued on next page]

(54) Title: METHOD FOR A MOSAIC PROGRAM GUIDE



(57) Abstract: A method and apparatus for generating a mosaic program guide. The method comprising; generating I frames from a coded video bit stream; placing each I frame into one of a multiplicity of mosaic windows; and combining the multiplicity of mosaic windows into a mosaic video frame.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD FOR A MOSAIC PROGRAM GUIDE

The present invention relates to the field of digital television; more specifically, it relates to a method for generating a mosaic program guide for digital television.

A mosaic program guide consists of a combination of different video frames presented in windows on a display device such as a video monitor. Each video frame is derived from a different program, and only one video frame is displayed in each window. Generally, the video frame within each window is refreshed at some periodic rate. Mosaic program guides help viewers to preview and navigate through the numerous programs transmitted by digital television systems. However, providing mosaic program guides is costly and time consuming. One technique for generating a mosaic program guide requires simultaneous video decoding and presentation of multiple programs in multiple windows. This technique requires very fast and expensive equipment. Another technique for generating a mosaic program guide requires a service provider to generate a mosaic guide and then deliver the mosaic program guide as a single program that appears to be broken into windows. This places additional cost on the service provider in terms of equipment and human resources as well as using up bandwidth that could otherwise be used for programs. When several hundred programs are available, this is not a trivial undertaking on the service providers part.

Therefore, there is a need for a method of generating a mosaic program guide with minimum additional cost.

A first aspect of the present invention is a method of generating a mosaic program guide comprising; generating I frames from a coded video bit stream; placing each I frame into one of a multiplicity of mosaic windows; and combining the multiplicity of mosaic windows into a mosaic video frame.

A second aspect of the present invention is an apparatus for generating a mosaic program guide comprising: means for generating I frames from a coded video bit stream; means for placing each I frame into one of a multiplicity of mosaic windows; and means for combining the multiplicity of mosaic windows into a mosaic video frame.

A third aspect of the present invention is a receiver for generating a mosaic program guide comprising: means for receiving an input signal and generating a coded bit stream; a de-multiplexer adapted to receive the coded bit stream and adapted to generate a

coded video bit stream; a video decoder adapted to select I frame data from the coded video bit stream and decode and generate a sequence of I frames.

A fourth aspect of the present invention is a receiver for generating a mosaic program guide comprising: a first tuner and demodulator adapted to receive an input signal and adapted to generate a first coded bit stream; a first a de-multiplexer adapted to receive the first coded bit stream and adapted to generate a first coded video bit stream; a first video decoder adapted to receive the first coded video bit stream and generate a sequence of video frames from a single program; a second tuner and demodulator adapted to receive the input signal and adapted to generate a second coded bit stream; a second a de-multiplexer adapted to receive the second coded bit stream and adapted to generate a second coded video bit stream; and a second video decoder adapted to select I frame data from the second coded video bit stream and decode and generate a sequence of I frames.

The features of the invention are set forth in the appended claims. The invention itself, however, will be best understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

FIG. 1 is an illustration of a display device displaying a mosaic program guide according to the present invention;

FIG. 2 is an illustration of a display device displaying a mosaic program guide and a main program according to the present invention;

FIG. 3 is a diagram illustrating video a typical sequence of video frames that are encoded into a digital data stream;

FIG. 4 is a schematic block diagram of a receiver for generating a mosaic program guide according to the present invention;

FIG. 5 is a flowchart illustrating the method steps for generating a mosaic program guide according to the present invention;

FIG. 6A is a schematic block diagram of a first application of the present invention;

FIG. 6B is a schematic block diagram of a second application of the present invention; and

FIG. 6C is a schematic block diagram of a third application of the present invention.

The term frame is interchangeable with the term picture when used in the context of video images. The term I frame (intra frame) is defined as a frame of video that is coded using prediction only from decoded samples within the same frame. The term P frame (predictive frame) is defined as a frame of video data coded using inter prediction from previously decoded reference frames, using motion vectors. The term B frame (bi-directional predictive frame) is defined as a frame coded using multiple inter prediction blocks. A block is an N x M array of samples or transform coefficients. A program guide is defined as a mosaic of scaled frames from different programs arranged in a pattern. Scaling is defined as a process of modifying a video frame to change relationship between the number of display device pixels and the number of pixels of a video frame, according to an algorithm, using all or a subset of the pixels of the video.

FIG. 1 is an illustration of a display device displaying a mosaic program guide according to the present invention. In FIG. 1, a display device 100 includes a screen 105 subdivided into mosaic windows 110A, 110B, 110C, 110D, 110E and 110F. In one example, display device 100 is a television monitor. In a second example, display device 100 is a projector projecting mosaic windows 110A through 110F onto screen 105. Within each mosaic window 110A through 110F a corresponding different mosaic image 1 through 6 is displayed. Each mosaic image 1 through 6 is, for example, a video frame from a different program. Mosaic images 1 through 6 may be updated periodically. Mosaic images 1 through 6 may be considered as constituting a program guide of six programs, allowing a viewer to sample the six programs before deciding which program to view. While six mosaic images are illustrated, any number of mosaic images in any geometric arrangement of windows may be displayed.

FIG. 2 is an illustration of a display device displaying a mosaic program guide and a main program according to the present invention. In FIG. 2, window 105 of display device 100 is subdivided into mosaic windows 110A, 110B, 110C and main window 115. Mosaic windows 110A through 110C display mosaic images 1 through 3, respectively. Mosaic images 1 through 3 are video frames from different programs. Main window 115 displays a main program image, which is, at any instant of time, a video frame of a program being viewed. The main program image is refreshed at normal rates and is accompanied by corresponding audio. Generally, the mosaic images 1 through 3 are

refreshed at a slower than normal rate. While three mosaic images are illustrated, any number of mosaic images in any geometric arrangement of windows may be displayed.

FIG. 3 is a diagram illustrating a typical sequence of video frames that are encoded into a digital data stream. A digital data stream, such as the transport stream of the motion pictures experts group (MPEG) is comprised of digital data (along with other data, such as audio data) representing a temporal sequence of video frames of different types. Only the video frame sequence is illustrated in FIG. 3. In FIG. 3, a portion of a temporal sequence of video frames 120 includes I frames 125, P frames 130 and B frames 135. Each program in a transport stream includes its own I, P, and B frames. The main program image displayed in window 115 of FIG. 2 requires the decoding and presentation of all I frames 125, P frames 130 and B frames 135 belonging to a single program (i. e the main program). Mosaic images displayed in mosaic windows 110A through 110F of FIG. 1 and mosaic windows 110A through 110C of FIG. 2 are decoded and presented I frames 125 from different programs. I frames are used because they do not require decoding of any other frames in order to have a complete frame. Further, the amount of decoding required is less since I frames are not compressed as much as P or B frames. Therefore, in the present invention, the mosaic images are generated in the receiver and not by the service or content provider and are not complete video programs but samples.

FIG. 4 is a schematic block diagram of a receiver for generating a mosaic program guide according to the present invention. In FIG. 4, receiver 140 includes a tuner and demodulator 145, a de-multiplexer and decryptor 150, an audio decoder 155 and a video decoder 165. Tuner and demodulator 145 receives an input signal 170 and generates a coded bit stream 175 (for MPEG a transport stream). De-multiplexer and decryptor 150 receives code bit stream 175 and generates a coded audio bit stream 180 (for MPEG an audio elementary stream) and a coded video bit stream 185 (for MPEG, a video elementary stream). Audio decoder 155 receives coded audio bit stream 180 and generates a playable audio out signal 190.

Video decoder 165 includes a program selector 160, a video bit buffer 195, a variable length decoder (VLD) 200, an inverse quantizer 205, an inverse discrete cosine transformer (IDCT) 210, a reconstructor 215, a window composer 220, a motion compensator 225, an anchor frame storeage 230 and a video controller 235. VLD 200 further includes a frame detector 240. Coded video bit stream 185 passes through program

selector 160 and into video bit buffer 195. Program selector 160 allows selection of specified channels. Video bit buffer 195 prevents overloading video decoder 165.

For normal operation (i. e. playing a main program), video controller 235 selects programs via a program select signal 245 and video bit buffer 195 receives coded video bit stream 185, and passes the coded video bit stream in temporally buffered bursts of data to VLD 200. VLD 200, along with inverse quantizer 205 and IDCT 210 generate pixel data 250 (either an I frame in the case of an I frame or pixel by pixel prediction errors in the case of P frames or B frames) degraded by quantization. VLD 200 also generates motion vectors 255 which are received by motion compensator 225 which generates motion compensated predicted pixels 260 from motion vectors 255 and pixels in anchor window composer 230. Reconstructor 215 combines pixel data 250 and motion compensated predicted pixels 260 into reconstructed pixels 265. Reconstructed pixels 265 are passed to window composer 220 and anchor window composer 230. Window composer 220 composes reconstructed pixels 265 for display and generates a displayed video out signal 270. In normal mode, window composer 220 simply generates one "full screen" window and fills the display space with one frame (at a time).

For mosaic operation (i. e. displaying a program guide as illustrated in FIG. 5), video controller 235 selects channels via channel select signal 245 and video bit buffer 195 receives coded video bit stream 185, and passes the coded video bit stream in temporally buffered bursts of data to VLD 200. When frame detector 240 detects an I-frame video, controller 235 sends a mosaic mode signal 275A to motion compensator 225 to turn motion compensation off, a mosaic mode signal 275B to anchor frames storage to disable receiving reconstructed pixels 265 and mosaic mode signal 275C to window composer 220 to place the window composer in mosaic mode (e. g. scale I frames and place I frames into multiple windows). When frame detector 240 detects a P frame or B frame, video controller 235 instructs VLD 200 to ignore the frame and no data is passed out of the VLD. Thus, pixel data 250 will contain only I frames. In mosaic mode, window composer 220 scales each frame of a different program to fill one mosaic window, assembles the windows into a mosaic frame and presents the mosaic frame to the video display device. Window composer 220 stores each I frame and replaces older I-frames from each program with newer I frames from each program so the mosaic frame is constantly updated. Thus,

the mosaic frame is used to refresh the display device, while the mosaic frame itself is updated as new I frames are received.

Video decoder 165 can operate in mixed mode (as illustrated in FIG. 2) by allowing decoding of P frames and B frames of a selected program while blocking decoding of P frames and B frames of all other programs, and appropriate switching of mosaic mode control signals 275A, 275B and 275C. In mixed mode, window composer 220 scales each frame of a different program to fill one mosaic window and scales the fully decoded video program to fit into a main window.

FIG. 5 is a flowchart illustrating the method steps for generating a mosaic program guide according to the present invention. In step 280, the receiver is enabled and an input signal is received. In step 285 the receiver is set to mosaic mode and programs to include in the mosaic program guide are selected. In step 290, the input signal is de-multiplexed (and decrypted if necessary) into an elementary video stream. In step 295, it is determined if an I-frame has been detected, and if so, if the detected I frame belongs to a program selected for display in the video guide. If the detected frame is not an I-frame (for example a P frame or a B frame), or is an I frame from a non-selected program, then the method loops back to step 290. If the detected frame is an I frame from a selected program then in step 300 the I frame is decoded. Next in step 305, each program's last decoded and stored I frame is replaced with each program's latest decoded I frame and the mosaic frame is updated. In step 310, the mosaic frame is displayed and refreshed as required. The method continuously loops back to step 290.

FIG. 6A is a schematic block diagram of a first application of the present invention. In FIG. 6A, a receiver 350 includes a broadband modem 355 (or a standard modem), a de-multiplexer and decryptor 360, a video decoder 365, an audio decoder 370 and a receiver controller 375. Video decoder 365 is identical to video decoder 165 illustrated in FIG. 4 and described supra. De-multiplexer 360 receives a broadband coded bit signal from broadband modem 355, and in response to control signal 380A selects which broad band signals to compose into video elementary stream 385 and audio elementary stream 390. Audio decoder 370 receives audio elementary stream 390 and generates a playable audio out signal. Video decoder 365 receives video elementary stream 385 and in response to a control signal 380B generates a series of decoded I frames for display.

FIG. 6B is a schematic block diagram of a second application of the present invention. In FIG. 6B, a receiver 395 is similar to receiver 350 illustrated in FIG. 6A except broadband modem 355 (see FIG. 6A) is replaced with a radio frequency (RF) tuner and demodulator (or simply an RF tuner) 400 which generates coded bit stream (for MPEG, a transport stream) and de-multiplexer and decryptor and decryptor 360 is replaced with de-multiplexer and decryptor 360A. De-multiplexer and decryptor 360A need not have the capacity of de-multiplexer and decryptor 360 because a control signal 380C is provided from receiver controller 375 to select output from tuner and demodulator 400. Video decoder 365 receives video elementary stream 385 and in response to a control signal 380B generates a series of decoded I frames for display.

FIG. 6C is a schematic block diagram of a third application of the present invention. In FIG. 6A, a receiver 405 includes first and second RF tuner and demodulators 410A and 410B, first and second de-multiplexers and decryptor 415A and 415B, a first video decoder 420, a video decoder 425, an audio decoder 430, a receiver controller 435 and a mixer 440. First video decoder 420 is identical to video decoder 165 illustrated in FIG. 4 and described supra. Second video decoder 425 is similar to video decoder 165 illustrated in FIG. 4 and described supra except that the second video decoder need not contain a motion compensator or anchor frame storage and the decoder may be modified to recognize and decode only I-frames. First and second tuner and demodulators may or may not be identical and first and second de-multiplexers and decryptor 415A and 415B may or may not be identical

In operation first tuner and demodulator 410A, first de-multiplexer and decryptor 415A, and first video decoder 420 together generate and present all video frames of a main program to mixer 440. Second tuner and demodulator 410B, second de-multiplexer and decryptor 415B, and second video decoder 425 together generate and present all I frames of a selected program guide (mosaic) programs to mixer 440. Mixer 440 then scales each mosaic frame and main frame to fit corresponding windows with a single frame, assembles the scaled frames into a single displayable frame.

Receiver 405 can also produce normal video and mosaic only mode video via appropriately applied control signals 445A, 445B, 445C, 445D, 445E, 445F and 445G. The present invention is applicable to all digital communications standards using I frames, P frames and B frames, including but not limited to MPEG-1, MPEG-2, MPEG-4, MPEG-

7, International telecommunications Union Standardization Sector (ITU-T) H264, digital satellite system (DSS) data structures or other standards that share common data stream structures with or are built upon the MPEG standard. In the case of ITU-T H264 standard, an additional type of frame, an SP frame is allowed. SP frames are ignored, similarly to P frames and B frames when the invention is in mosaic or program guide mode.

The description of the embodiments of the present invention is given above for the understanding of the present invention. It will be understood that the invention is not limited to the particular embodiments described herein, but is capable of various modifications, rearrangements and substitutions as will now become apparent to those skilled in the art without departing from the scope of the invention. Therefore, it is intended that the following claims cover all such modifications and changes as fall within the true spirit and scope of the invention.

CLAIMS:

1. A method of generating a mosaic program guide comprising;
generating I frames from a coded video bit stream;
placing each I frame into one of a multiplicity of mosaic windows;
and
combining said multiplicity of mosaic windows into a mosaic video frame.

2. The method of claim 1, further including scaling each I frame to fit into one of said mosaic windows.

3. The method of claim 1, wherein each mosaic window is associated with a different program.

4 The method of claim 3, wherein the I frame of each mosaic window is replaced with a later decoded I frame of the same program.

5. The method of claim 4, wherein said later decoded I frame is the next I frame of the same program.

6. The method of claim 1, further including selecting programs for which said I frames are generated.

7. The method of claim 1, wherein said generating I frames includes:
selecting from a coded video bit stream coded data, said coded data representing I frames; and
decoding and decompressing said coded data into said I frames.

8. The method of claim 1, further including:
generating a set of video frames from a selected program from said coded video bit stream; and

sequentially scaling and placing each video frame of said set of video frames into a selected mosaic window of said multiplicity of mosaic windows.

9. The method of claim 1, further including displaying said mosaic frame on a display device.

10. An apparatus for generating a mosaic program guide comprising:

means for generating I frames from a coded video bit stream;

means for placing each I frame into one of a multiplicity of mosaic windows; and

means for combining said multiplicity of mosaic windows into a mosaic video frame.

11. The apparatus of claim 10, further including means for scaling each frame to fit into one of said mosaic windows.

12. The apparatus of claim 10, wherein each mosaic window is associated with a different program.

13. The apparatus of claim 12, wherein the I frame of each mosaic window is replaced with a later decoded I frame of the same program.

14. The apparatus of claim 13, wherein said later decoded I frame is the next I frame of the same program.

15. The apparatus of claim 10, further including means for selecting programs for which said I frames are generated.

16. The apparatus of claim 10, wherein said means for generating I frames includes:

means for selecting from a coded video bit stream coded data, said coded data representing I frames; and

means for decoding and decompressing said coded data into said I frames.

17. The apparatus of claim 10, further including:

means for generating a set of video frames from a selected program from said coded video bit stream; and

means for sequentially scaling and placing each video frame of said set of video frames into a selected mosaic window of said multiplicity of mosaic windows.

18. A receiver for generating a mosaic program guide comprising:

means for receiving an input signal and generating a coded bit stream;

a de-multiplexer adapted to receive said coded bit stream and adapted to generate a coded video bit stream;

a video decoder adapted to select I frame data from said coded video bit stream and decode and generate a sequence of I frames.

19. The receiver of claim 18 wherein said means for receiving an input signal is selected from the group of devices consisting of modems, broadband modems, RF tuners and RF tuners and demodulators.

20. A receiver for generating a mosaic program guide comprising:

a first tuner and demodulator adapted to receive an input signal and adapted to generate a first coded bit stream;

a first a de-multiplexer adapted to receive said first coded bit stream and adapted to generate a first coded video bit stream;

a first video decoder adapted to receive said first coded video bit stream and generate a sequence of video frames from a single program;

a second tuner and demodulator adapted to receive said input signal and adapted to generate a second coded bit stream;

a second a de-multiplexer adapted to receive said second coded bit stream and adapted to generate a second coded video bit stream; and

a second video decoder adapted to select I frame data from said second coded video bit stream and decode and generate a sequence of I frames.

21. The receiver of claim 20, further including a mixer adapted to present said sequence of video frames in a first window of a mosaic frame and said I frames in additional windows of said mosaic frame.

22. The receiver of claim 21, wherein I frames of the same program are presented sequentially in order of I frame decoding in the same window of said additional windows

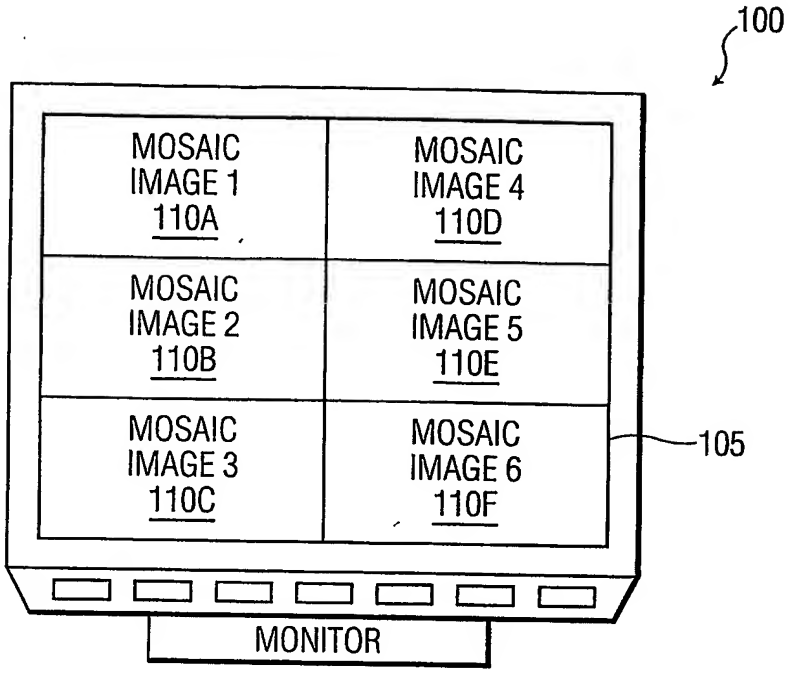
100
MOSAIC IMAGE 1 110A
MOSAIC IMAGE 4 110D
MOSAIC IMAGE 2 110B
MOSAIC IMAGE 5 110E
MOSAIC IMAGE 3 110C
MOSAIC IMAGE 6 110F
105
MONITOR

FIG. 1

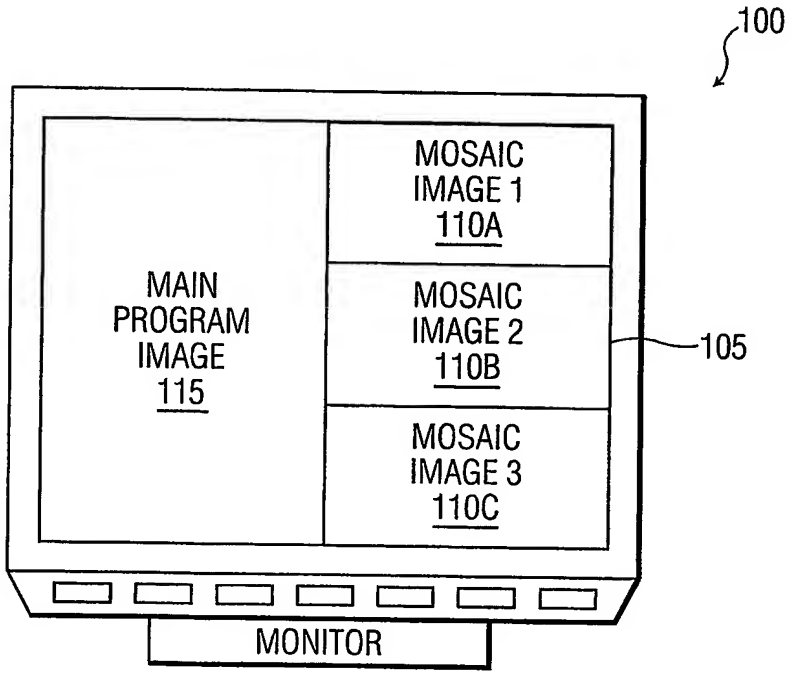
100
MAIN PROGRAM IMAGE 115
MOSAIC IMAGE 1 110A
MOSAIC IMAGE 2 110B
MOSAIC IMAGE 3 110C
105
MONITOR

FIG. 2

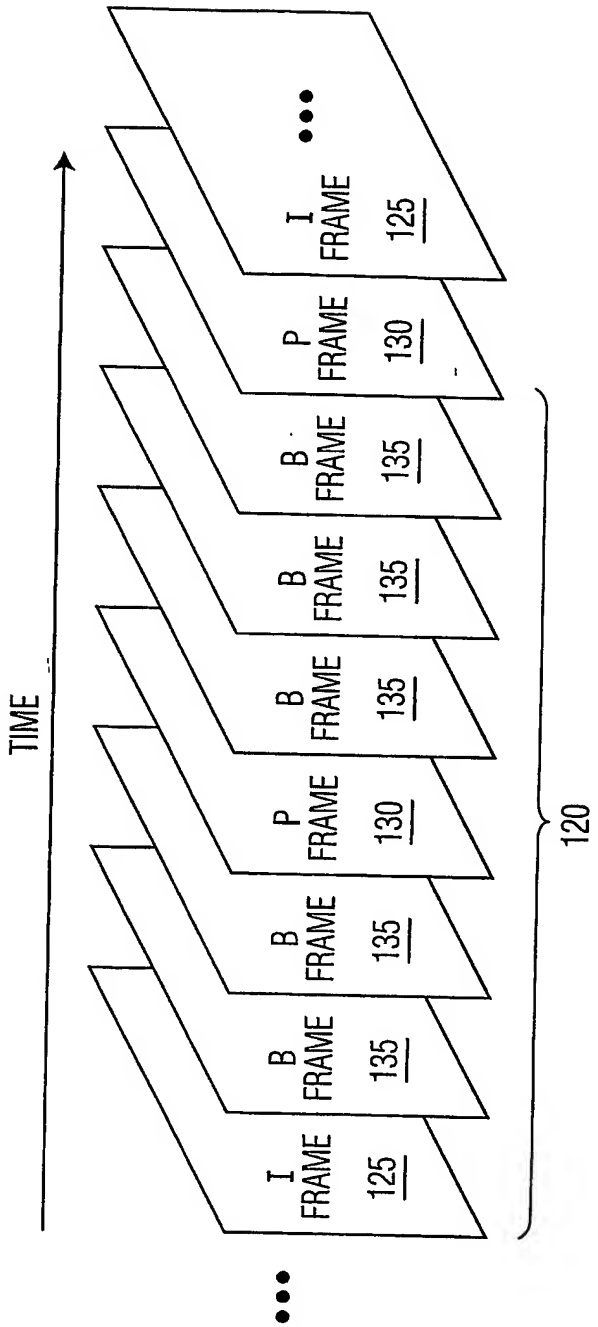
TIME
I FRAME 125
B FRAME 135
B FRAME 135
P FRAME 130
B FRAME 135
B FRAME 135
B FRAME 135
P FRAME 130
I FRAME 125
120

FIG. 3

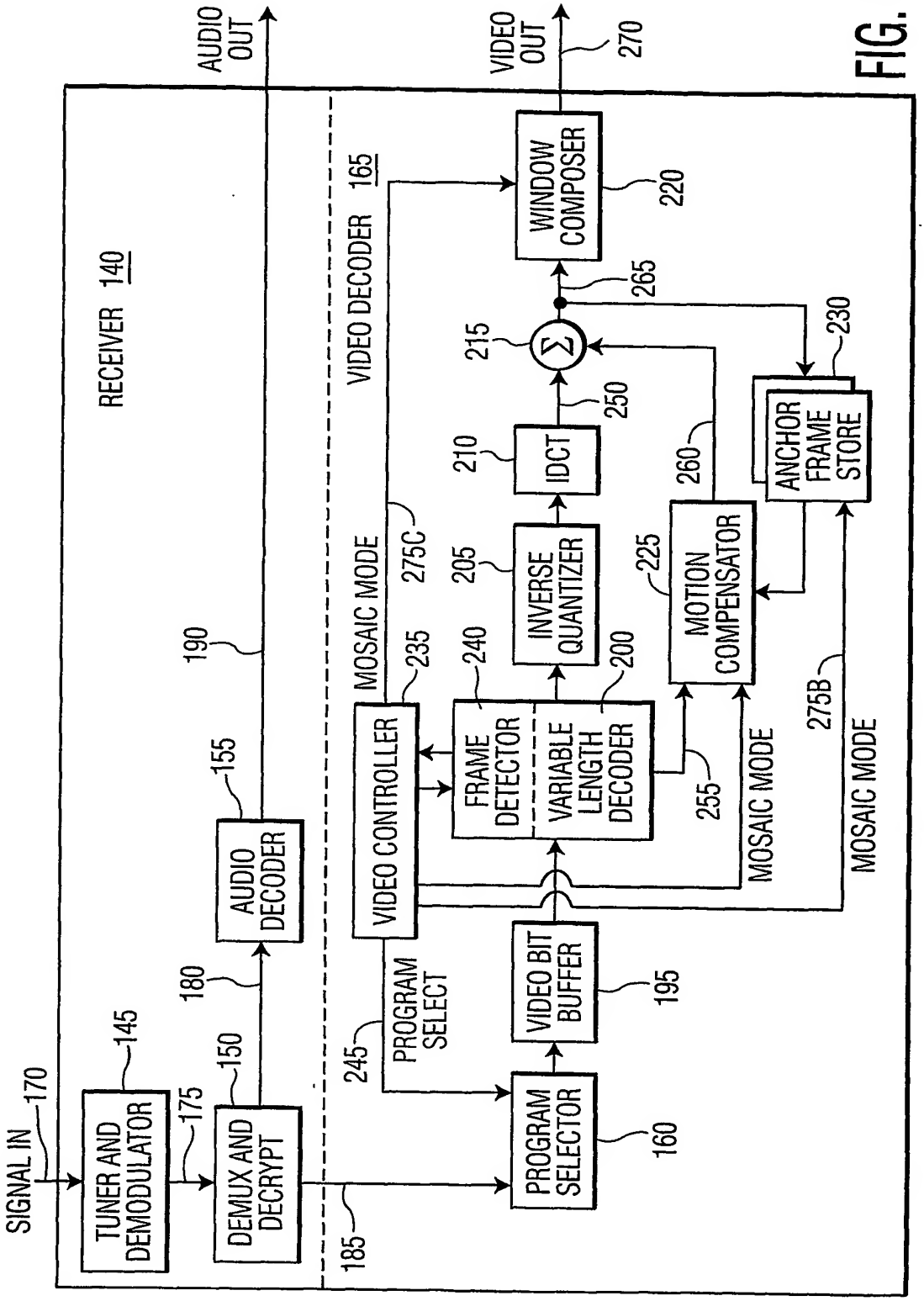
SIGNAL IN
170
TUNER AND DEMODULATOR
145
DEMUX AND DECRYPT
150
175
180
185
AUDIO DECODER
155
190
AUDIO OUT
RECEIVER 140
VIDEO DECODER 165
VIDEO CONTROLLER
MOSAIC MODE
235
275C
PROGRAM SELECT
245
PROGRAM SELECTOR
160
VIDEO BIT BUFFER
195
FRAME DETECTOR
240
VARIABLE LENGTH DECODER
200
255
INVERSE QUANTIZER
205
IDCT
210
250
215
Σ
265
WINDOW COMPOSER
220
VIDEO OUT
270
MOTION COMPENSATOR
225
260
ANCHOR FRAME STORE
230
275B
MOSAIC MODE
MOSAIC MODE

FIG. 4

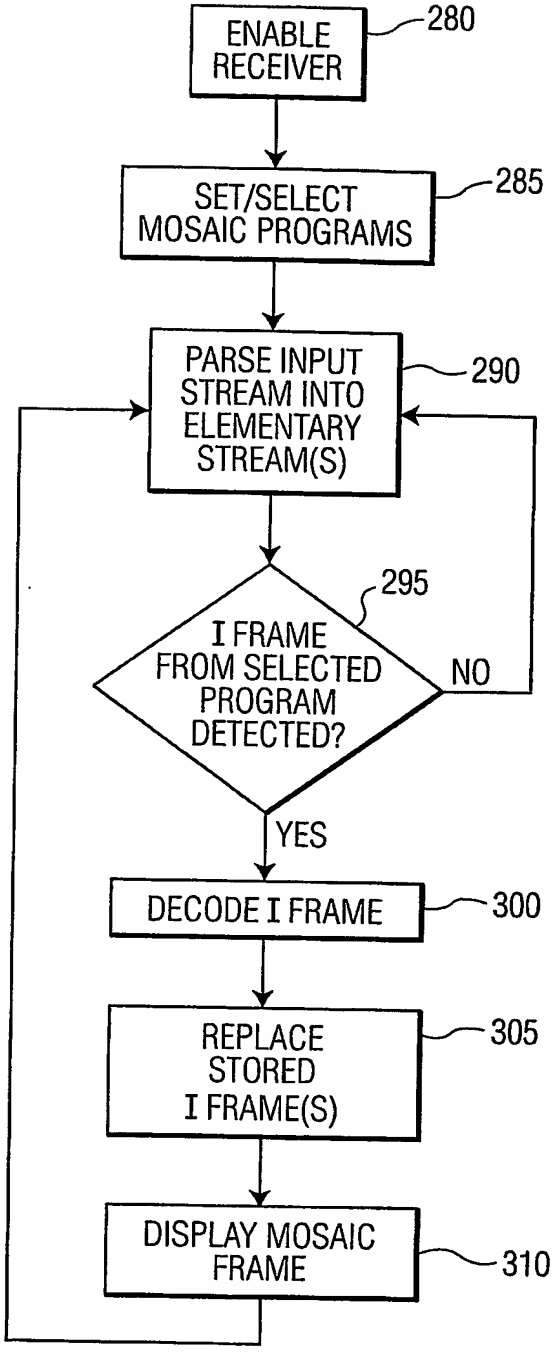
ENABLE RECEIVER
280
SET/SELECT MOSAIC PROGRAMS
285
PARSE INPUT STREAM INTO ELEMENTARY STREAM(S)
290
I FRAME FROM SELECTED PROGRAM DETECTED?
295
NO
YES
DECODE I FRAME
300
REPLACE STORED I FRAME(S)
305
DISPLAY MOSAIC FRAME
310

FIG. 5

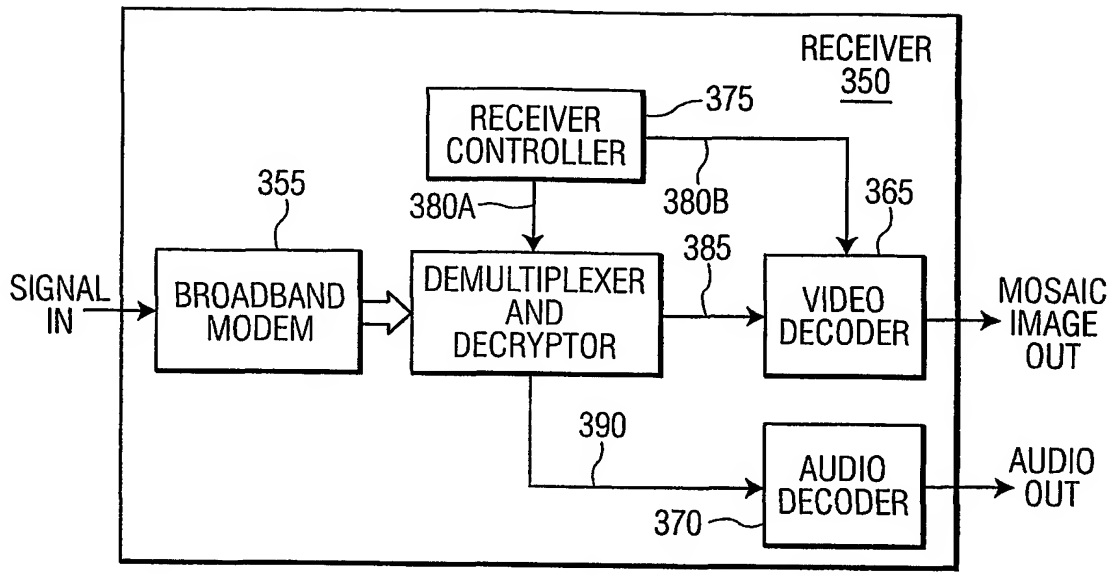
RECEIVER
350
RECEIVER CONTROLLER
375
355
380A
380B
365
385
SIGNAL IN
BROADBAND MODEM
DEMULTIPLEXER AND DECRYPTOR
VIDEO DECODER
MOSAIC IMAGE OUT
390
AUDIO DECODER
AUDIO OUT
370

FIG. 6A

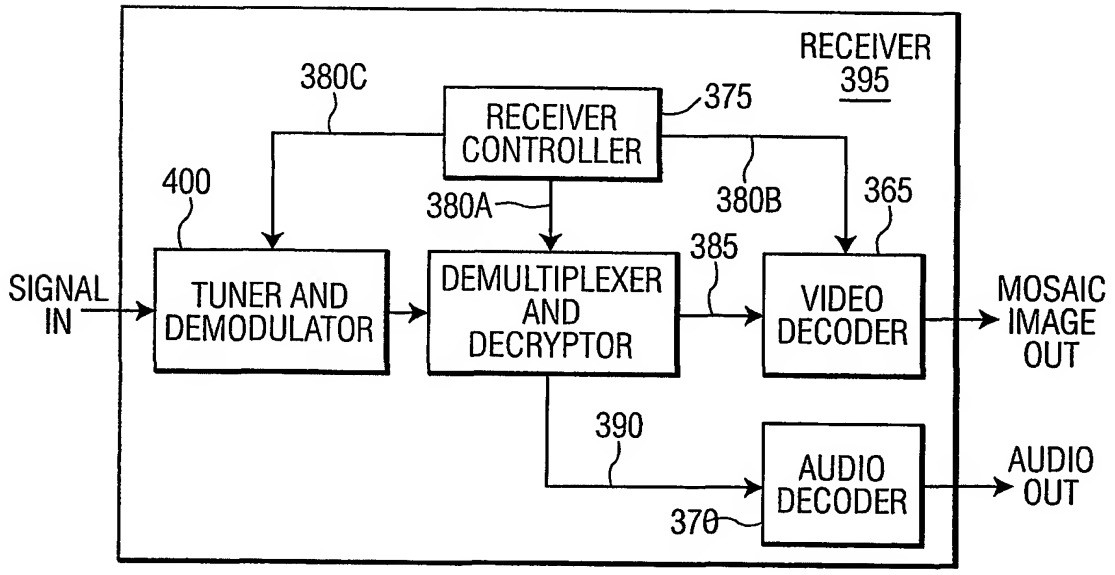
RECEIVER
395
380C
RECEIVER CONTROLLER
375
400
380A
380B
365
385
SIGNAL IN
TUNER AND DEMODULATOR
DEMULTIPLEXER AND DECRYPTOR
VIDEO DECODER
MOSAIC IMAGE OUT
390
AUDIO DECODER
AUDIO OUT
370

FIG. 6B

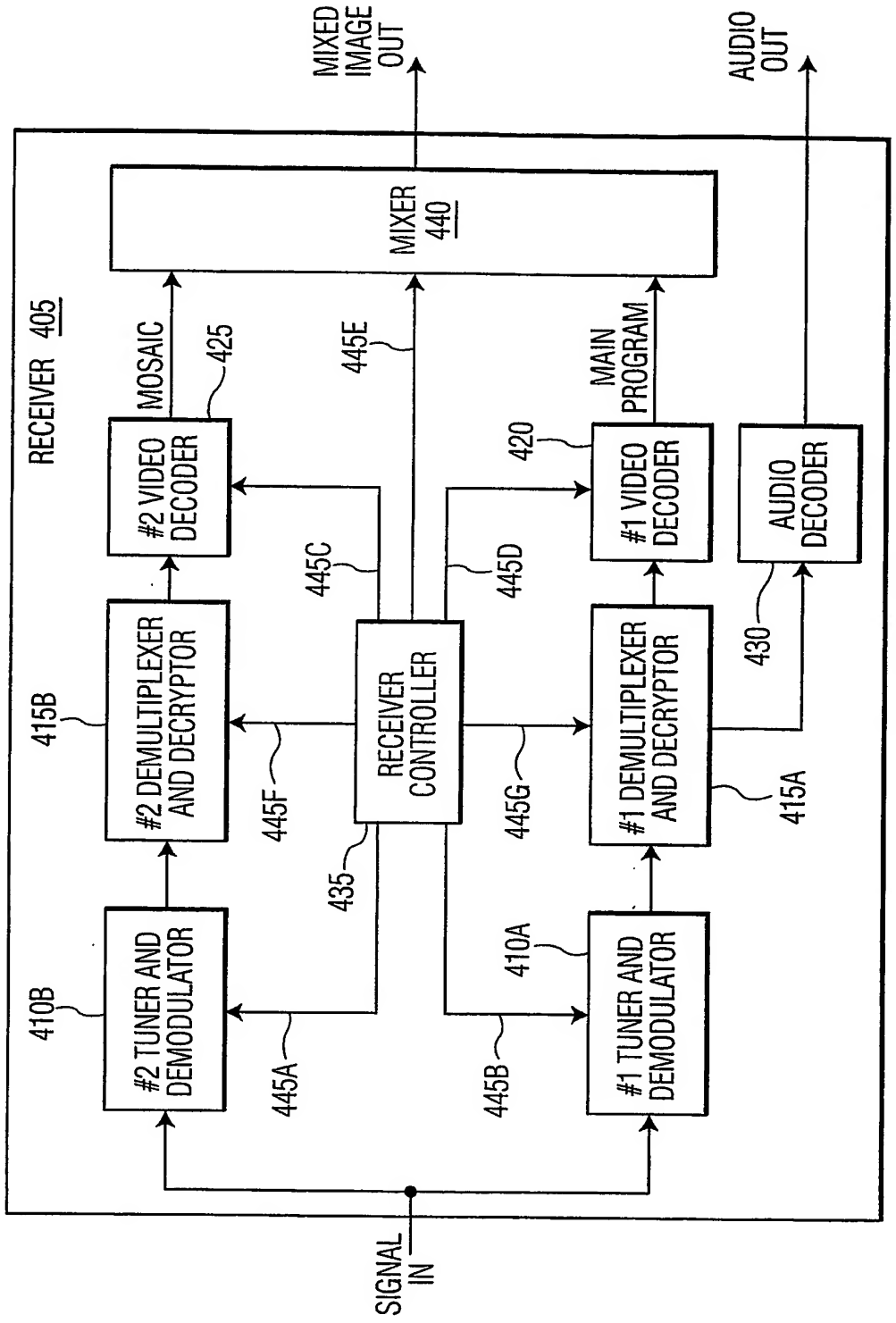
MIXED IMAGE OUT
AUDIO OUT
MIXER 440
RECEIVER 405
MOSAIC
425
MAIN PROGRAM
445E
420
#2 VIDEO DECODER
#1 VIDEO DECODER
AUDIO DECODER
445C
445D
430
415B
#2 DEMULTIPLEXER AND DECRYPTOR
RECEIVER CONTROLLER
#1 DEMULTIPLEXER AND DECRYPTOR
445F
445G
415A
435
410A
410B
#2 TUNER AND DEMODULATOR
#1 TUNER AND DEMODULATOR
445A
445B
SIGNAL IN

FIG. 6C

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB 03/05910

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04N5/445 H04N5/45

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
COMPENDEX, EPO-Internal, INSPEC, PAJ, IBM-TDB, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 020 930 A (LEGRAND LUDOVIC) 1 February 2000 (2000-02-01)	1-19
A	column 1, line 5 -column 2, line 24 column 3, line 15 -column 4, line 57 column 6, line 33 - line 46 column 7, line 3 -column 8, line 26 figures 1,2,7,8	20-22
X	US 6 115 080 A (REITMEIER GLENN ARTHUR) 5 September 2000 (2000-09-05) column 3, line 18 - line 65 column 5, line 33 - line 35 column 6, line 11 - line 19 column 8, line 37 - line 40 column 10, line 17 - line 21 column 11, line 1 - line 27 column 15, line 66 -column 16, line 50 figures 1,2,3,4,6A,6B	1-22

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 March 2004	17/03/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Schreib, F

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB 03/05910

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 01 26367 A (MICROTUNE INC) 12 April 2001 (2001-04-12) abstract page 10, line 9 - line 14 figures 1-3,5	1-22
A	WO 01 56292 A (OPEN TV INC) 2 August 2001 (2001-08-02) page 4, line 3 - line 7 page 8, line 3 - line 7 page 13, line 1 - line 15 page 26, line 3 - line 20 page 27, line 16 - line 18 page 35, line 13 - line 16 figures 2,3,4A,4B	1-22
A	US 5 900 868 A (DUHAULT JAMES ET AL) 4 May 1999 (1999-05-04) column 1, line 34 - line 40 column 2, line 19 - line 32 column 3, line 37 -column 4, line 56 column 5, line 60 -column 6, line 8 figures 1-3	1-22

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